

IN THE CLAIMS

1-32. (Canceled)

~~1-33.~~ (Previously presented) A method for estimating a carrier frequency, the method comprising the steps of:

Step A: ^{defining} ~~Defining~~ R levels, indexed by consecutive integers 1 to R, wherein

each level r is associated with a set of data blocks that together make up a set of data that is associated with a received signal;

each data block in the set of data blocks associated with a level r, where r is greater than 1, is made up from data blocks from the set of data blocks associated with level r-1;

the set of data blocks associated with the level R comprises a single data block;

each level r is associated with a set of frequencies; and

the set of frequencies associated with the level R comprises a set of candidate frequencies;

Step B: for each data block in the set of data blocks associated with the first level, calculating at each frequency in the set of frequencies associated with the first level, a pair of I and Q integrals to produce corresponding pairs of I and Q correlation values;

Step C: selecting level 2 to be a current level and selecting level 1 to be a previous level;

Step D0: selecting a data block in the set of data blocks associated with the current level that has not been previously selected to be a selected data block;

Step D1: selecting a set of constituent data blocks from the set of data blocks associated with the previous level that make up the selected data block to be a selected set of constituent data blocks;

Step D2: selecting a frequency from the set of frequencies associated with the current level to be a selected frequency;

Step D3: selecting the pairs of I and Q correlation values corresponding to each data block in the selected set of constituent data blocks and corresponding to a frequency associated with the previous level which is close to the selected frequency, to be the selected pairs of I and Q correlation values;

Step D4: selecting weights for the selected pairs of I and Q correlation values, based on a difference between the target frequency and the frequency at which the selected pairs of I and Q correlation values are calculated, and also based on the position of the data block that corresponds to the selected pair of I and Q correlation values;

Step D5: weighting the selected pairs of I and Q correlation values according to the selected weights to produce a set of weighted pairs of I and Q correlation values corresponding to the selected data block and the selected frequency;

Step D6: summing the weighted pairs of I and Q correlation values to produce a pair of I and Q correlation values associated with the current level, selected data block, and the selected frequency;

Step D7: repeating steps D2-D6 until every frequency from the set of frequencies associated with the current level has been selected to be the selected frequency; and

Step D8: repeating steps D0-D7 until every data block in the set of data blocks associated with the current level has been selected to be the selected data block;

Step E: If the current level r is not level R , updating the current level to be level $r+1$, updating the previous level to be level r , and repeating steps D0-E; and

Step F: Estimating the carrier frequency on the basis of the pairs of I and Q correlation values associated with level R and with the frequencies in the set of candidate frequencies.

2 ~~34~~. (Previously presented) The method of Claim ~~33~~¹ wherein Step F comprises the steps of:

Step F1: for each frequency in the set of candidate frequencies, calculating a magnitude associated with the corresponding pair of I and Q correlation values; and

Step F2: estimating a carrier frequency by selecting a frequency in the set of candidate frequencies for which the associated magnitude is largest.

3 ~~35~~. (Previously presented) The method of Claim ~~34~~² wherein the received signal is a GPS signal.

4 ~~36~~. (Previously presented) The method of Claim ~~34~~² wherein the maximum magnitude is compared against a threshold.

5 ~~37~~. (Previously presented) The method of Claim ~~36~~⁴ wherein the received signal is

a GPS signal.

6 ~~38~~. (Previously presented) The method of Claim ~~33~~¹ wherein the set of data that is associated with the received signal comprises sampled data obtained by sampling the received signal.

7 ~~39~~. (Previously presented) The method of Claim ~~38~~⁶ wherein the received signal is a GPS signal.

8 ~~40~~. (Previously presented) The method of Claim ~~33~~¹ wherein the set of data that is associated with the received signal is an analog signal.

9 ~~41~~. (Previously presented) The method of Claim ~~40~~⁸ wherein the received signal is a GPS signal.

10 ~~42~~. (Previously presented) The method of Claim ~~33~~¹ wherein the received signal is a GPS signal.

11 ~~43~~. (Previously presented) The method of Claim ~~42~~¹⁰ wherein the step of calculating the pair of I and Q correlation integrals is performed coherently based on navigation bit information associated with a global positioning satellite vehicle.

12 ~~44~~. (Previously presented) The method of Claim ~~42~~¹⁰ wherein the set of candidate frequencies is determined on the basis of an intermediate frequency employed by a receiver and a Doppler shift associated with a global positioning satellite vehicle.

13 ~~45~~. (Previously presented) The method of Claim ~~33~~¹, wherein the steps B-E are repeated for each hypothesized delay value over a range of hypothesized delay values, to produce a pair of I and Q correlation values corresponding to each candidate frequency and

each hypothesized delay value.

14 ~~46~~.¹³ (Previously presented) The method of Claim ~~45~~ wherein the received signal is a GPS signal.

15 ~~47~~.¹³ (Previously presented) The method of Claim ~~46~~, wherein the step of estimating the carrier frequency comprises the steps of:

for each candidate frequency within the set of candidate frequencies and for each hypothesized delay in the range of hypothesized delay values, calculating a magnitude associated with the corresponding pair of I and Q correlation values; and

selecting the hypothesized delay value and candidate frequency that has the highest magnitude calculation.

16 ~~48~~.¹⁵ (Previously presented) The method of Claim ~~47~~ wherein the received signal is a GPS signal.

17 ~~49~~.¹⁵ (Previously presented) The method of Claim ~~47~~ wherein the maximum magnitude is compared against a threshold.

18 ~~50~~.¹⁷ (Previously presented) The method of Claim ~~49~~ wherein the received signal is a GPS signal.

19 ~~51~~.¹ (Previously presented) The method of Claim ~~33~~, wherein the number R of levels equals 2.

20 ~~52~~.¹⁹ (Previously presented) The method of Claim ~~51~~ wherein the received signal is a GPS signal.

21 ~~53~~.¹ (Previously presented) The method of Claim ~~33~~, wherein the number of data

blocks iii the set of data blocks associated with each level is proportional to a length of the received signal.

22 ~~54~~. (Previously presented) The method of Claim ~~53~~²¹ wherein the received signal is a GPS signal.

23 ~~55~~. (Previously presented) The method of Claim ~~32~~¹, wherein every data in the set of data blocks associated with the same level has the same length.

24 ~~56~~. (Previously presented) The method of Claim ~~55~~²³ wherein the received signal is a GPS signal.

25 ~~57~~. (Previously presented) The method of Claim ~~58~~²³, wherein the number of frequencies in the set of frequencies associated with a level is proportional to the length of the data blocks associated with the level.

26 ~~58~~. (Previously presented) The method of Claim ~~57~~²⁵ wherein the received signal is a GPS signal.

27 ~~59~~. (Previously presented) A method for estimating a carrier frequency, the method comprising the steps of:

receiving data associated with a received signal;

determining a frequency range of interest;

determining a set of coarse frequencies within the frequency range of interest;

determining a set of fine frequencies within the frequency range of interest;

dividing the data into a set of data blocks;

for each data block of the set of data blocks, calculating I and Q correlation values associated with the data at each frequency from the set of coarse frequencies;

for every frequency of the set of fine frequencies, determining a selected frequency in the set of coarse frequencies, wherein the selected frequency is close in value to the frequency in the set of fine frequencies;

for each data block of the set of data blocks selecting I and Q correlation values corresponding to each coarse frequency to be the selected I and Q correlation values for the corresponding data block and coarse frequency;

selecting weights for the selected I and Q correlation values, based on a difference between a frequency in the set of fine frequencies and the corresponding selected frequency in the set of coarse frequencies, and also based on a position of the data block that corresponds to the selected pair of I and Q correlation values;

weighting the selected pairs of I and Q correlation values according to the selected weights to produce weighted pairs of I and Q correlation values;

computing an approximation to the I and Q correlation integrals over the entire data associated with the received signal, for each frequency in the set of fine frequencies, using the weighted pairs of I and Q correlation values; and

estimating the carrier frequency from within the set of fine frequencies by using the approximations to the I and Q correlation integrals at the frequencies in the set of fine frequencies.

28 ~~60~~. (Previously presented) The method of Claim ²⁷~~59~~ wherein all of the data blocks comprising the set of data blocks have the same length.

31 ~~61~~. (Previously presented) The method of Claim ~~59~~²⁷ wherein the length of the data blocks comprising the set of data blocks is chosen to minimize a measure of computational complexity.

32 ~~62~~. (Previously presented) The method of Claim ~~59~~²⁷ wherein the set of data that is associated with the received signal comprises sampled data obtained by sampling the received signal.

33 ~~63~~. (Previously presented) The method of Claim ~~62~~³² wherein the received signal is a GPS signal.

34 ~~64~~. (Previously presented) The method of Claim ~~59~~²⁷ wherein the set of data that is associated with the received signal is an analog signal.

35 ~~65~~. (Previously presented) The method of Claim ~~64~~³⁴ wherein the received signal is a GPS signal.

36 ~~66~~. (Previously presented) The method of Claim ~~59~~²⁷ wherein the received signal is a GPS signal.

37 ~~67~~. (Previously presented) The method of Claim ~~66~~³⁶ wherein calculating I and Q correlation values is performed coherently based on navigation bit information associated with a global positioning satellite vehicle.

38 ~~68~~. (Previously presented) The method of Claim ~~66~~³⁶ wherein the set of fine frequencies is determined on the basis of an intermediate frequency employed by a receiver and a Doppler shift associated with a global positioning satellite vehicle.

39 ~~69~~. (Previously presented) The method of Claim ~~66~~³⁶ wherein the set of coarse

frequencies is determined on the basis of an intermediate frequency employed by a receiver and a Doppler shift associated with a global positioning satellite vehicle.

40 ~~70~~. (Previously presented) The method of Claim ~~59~~²⁷, wherein the number of data blocks in the set of data blocks is proportional to a length of the received signal.

41 ~~71~~. (Previously presented) The method of Claim ~~70~~⁴⁰ wherein the received signal is a GPS signal.

29 ~~72~~. (Previously presented) The method of Claim ~~60~~²⁸, wherein the number of coarse frequencies is proportional to the length of the data blocks.

30 ~~73~~. (Previously presented) The method of Claim ~~72~~²⁹ wherein the received signal is a GPS signal.

42 ~~74~~. (Previously presented) The method of Claim ~~59~~²⁷, wherein the number of fine frequencies is proportional to the length of the data associated with the received signal.

43 ~~75~~. (Previously presented) The method of Claim ~~74~~⁴² wherein the received signal is a GPS signal.

44 ~~76~~. (Previously presented) The method of Claim ~~59~~²⁷, wherein the step of computing the approximation to the I and Q correlation integrals comprises the steps of:

Step A: zero-padding the weighted pairs of I and Q correlation values;

Step B: applying a Fast Fourier Transform on the zero-padded weighted pairs of I and Q correlation values; and

Step C: selecting the values of the Fast Fourier transform at appropriate frequencies to be the approximations to the I and Q correlation integrals at the

frequencies in the set of fine frequencies.

45 ~~77~~. (Previously presented) The method of Claim ~~76~~⁴⁴ wherein the received signal is a GPS signal.

46 ~~78~~. (Previously presented) The method of Claim ~~76~~⁴⁴ wherein a number of zeros introduced during Step A is determined by a frequency resolution associated with the set of fine frequencies.

47 ~~79~~. (Previously presented) The method of Claim ~~78~~⁴⁶ wherein the received signal is a GPS signal.

27
48 ~~80~~. (Previously presented) The method of Claim ~~59~~²⁷, wherein for each data block in the set of data blocks, the step of calculating I and Q correlation values comprises calculating the I and Q correlation values for each hypothesized delay value over a range of hypothesized delay values.

55 ~~81~~. (Previously presented) The method of Claim ~~80~~⁵⁴ wherein the received signal is a GPS signal.

48 ~~82~~. (Previously presented) The method of Claim ~~76~~⁴⁴, wherein the Steps A, B, and C are carried out for each hypothesized delay value over a range of hypothesized delay values.

50 ~~83~~. (Previously presented) The method of Claim ~~84~~⁴⁹ wherein the received signal is a GPS signal.

49 ~~84~~. (Previously presented) The method of Claim ~~82~~⁴⁸, wherein the step of estimating the carrier frequency from within the set of fine frequencies comprises the steps of:

calculating a magnitude of the approximations to the I and Q correlation

integrals for each frequency within the set of fine frequencies and for each hypothesized delay; and

selecting the hypothesized delay and carrier frequency that has the highest magnitude calculation.

51 ~~85~~. (Previously presented) The method of Claim ~~84~~⁴⁹ wherein the received signal is a GPS signal.

52 ~~86~~. (Previously presented) The method of Claim ~~84~~⁴⁹ wherein the highest magnitude is compared against a threshold.

53 ~~87~~. (Previously presented) The method of Claim ~~86~~⁵² wherein the received signal is a GPS signal.